

CLAIMS

1. A material processing system for performing a plurality of laboratory processing steps on a material sample, comprising:

5 a plurality of modular stations each performing at least one process in an overall process sequence, each modular station adapted to perform the at least one process in an automated way within a controlled environment unique to the modular station, at least one modular station adapted to provide material for processing to another modular station without human handling of the material.

10 2. The system of claim 1, wherein the material sample is a liquid.

3. The system of claim 1, wherein the material sample includes genetic material.

15 4. The system of claim 3, wherein a first modular station is adapted to perform an amplification process using the material sample, and a second modular station is adapted to perform a separation process on material provided from the first modular station resulting from the amplification process.

20 5. The system of claim 1, wherein at least one of the modular stations is adapted to perform liquid handling functions using the material sample.

25 6. The system of claim 5, wherein the at least one modular station includes a robotically controlled pipetting tool.

7. The system of claim 1, wherein at least one of the modular stations is adapted to perform a gel extrusion process.

30 8. The system of claim 1, wherein at least one of the modular stations is adapted to perform one of an automated amplification process using at least a portion of the material sample, an automated separation process using at least a byproduct formed

from processing the material sample, an automated electrophoresis process, and an automated picking process of material resulting from an electrophoresis process.

9. The system of claim 1, further comprising at least one transport system
5 that moves material between a first modular station and second modular station.

10. The system of claim 9, wherein the at least one transport system includes
a conveyor.

10 11. The system of claim 10, wherein a first robot associated with a first
modular station is adapted to move an object to a first position so that the transport
system can move the object to a second modular station to a second position where a
second robot associated with the second modular station can access the object.

15 12. The system of claim 1, wherein at least one of the modular stations has a
first environment and a second environment that is different than the first environment,
and wherein the material sample is moved from the first environment to the second
environment.

20 13. A method for processing genetic material, comprising:
inputting a genetic material into a material processing system; and
performing at least amplification and separation processes using the genetic
material without human handling of the genetic material.

25 14. A material processing system for performing a plurality of laboratory
processing steps on a material sample, comprising:
a plurality of modular stations each performing at least one process in an overall
process sequence, each modular station adapted to perform the at least one process in an
automated way; and

30 at least one transport device adapted to transport material for processing from a
first modular station to a second modular station without human handling of the material.

15. The system of claim 14, wherein the at least one transport device includes a non-robotic device that moves the material from the first modular station to the second modular station.

5 16. The system of claim 14, wherein a transport device is arranged to transport material between pairs of modular stations.

17. The system of claim 16, wherein the transport device includes a conveyor.

10 18. The system of claim 14, wherein each modular station is adapted to perform the at least one process in an automated way within a controlled environment unique to the modular station.

15 19. The system of claim 14, wherein the material sample includes genetic material.

20. A liquid handling device comprising:
a body having at least one bore formed in the body;
a plunger slidably engaged with the body within the bore;
20 a pipette tip holder that fluidly communicates with the bore; and
a linear servo motor that drives the plunger to slide within the bore, sliding of the plunger causing fluid to move between the pipette tip holder and the bore.

21. The device of claim 20, further comprising:
25 a linear encoder that provides position information for the plunger.

22. A gel extruder for extruding gel material suitable for gel electrophoresis processing, comprising:

30 an extruder body including an extrusion cavity having a first end and a second end; and

a liquid material supply apparatus that supplies a liquid material to the first end of the extruder body;

wherein the liquid material cools within the extrusion cavity to form a gel that exits from the second end of the extrusion cavity.

23. The extruder of claim 22, wherein the extrusion cavity is arranged so that the first end is lower than the second end.

24. The extruder of claim 22, wherein the extruder body includes a pair of spaced plates that define two sides of the extrusion cavity.

25. The extruder of claim 24, wherein at least one of the plates is cooled by a chilled liquid.

26. The extruder of claim 22, wherein the liquid material supply device includes a pump that delivers the liquid material under pressure to the first end of the extrusion cavity.

27. The extruder of claim 26, wherein the pressure of the liquid material entering the first end of the extrusion cavity forces the gel to exit from the second end of the extrusion cavity.

28. The extruder of claim 22, further comprising a cutting device that cuts gels extruded from the second end of the extrusion cavity.

29. The extruder of claim 22, further comprising a rotatable platform that receives a gel exiting from the second end of the extrusion cavity and rotates to place a gel in a receiving area.

30. The extruder of claim 29, further comprising a vacuum pump that evacuates air from the platform and creates a suction force to secure gels to the platform.

31. A method for forming gels suitable for use in a gel electrophoresis process, comprising:

providing a liquid material at a first end of an extrusion cavity;
forming a gel in the extrusion cavity using the liquid material; and
extruding the gel from a second end of the extrusion cavity.

5 32. The method of claim 31, wherein the step of forming a gel comprises
cooling the liquid material to form a gel.

10 33. The method of claim 31, wherein the step of providing a liquid material
comprises providing the liquid material at a first end of the extrusion cavity that is lower
than the second end of the extrusion cavity.

15 34. The method of claim 31, further comprising:
using the extruded gel in an electrophoresis process.

20 35. A well forming tool for forming wells in a gel that receive a liquid
material, comprising:
a comb-like element having a body and a plurality of tines extending from the
body, the tines adapted to be heated and inserted into the gel so that the tines each form a
well in the gel suitable for receiving the liquid material.

25 36. A method for forming wells in a gel, comprising:
providing a comb-like element having a plurality of tines; and
inserting the plurality of tines into the gel to form one well for each tine.

30 37. The method of claim 36, further comprising:
heating the tines to a temperature sufficient to melt the gel.

 38. The method of claim 36, further comprising:
grasping the comb-like element with a robotic-gripping tool.

 39. A method for plating a sample in a holder, comprising:
providing a sample holder;

placing the sample in the sample holder; and
plating the sample in the sample holder using a robotically-controlled plating
tool.

5 40. A method for performing a robotically-controlled liquid handling process,
comprising:

 providing a pipette tip tray having a lid over the tip tray; and

 removing the lid from the tip tray using a robotically-controlled tool to expose the
pipette tips for use by a liquid handling tool.

10 41. A method for performing a robotically-controlled liquid handling process,
comprising:

 providing a plurality of pipette tips;

 placing the plurality of pipette tips on a robotically controlled liquid handling
15 tool; and

 automatically confirming that the plurality of pipette tips are properly positioned
on the liquid handling tool.

20 42. The method of claim 41, wherein the step of automatically confirming
comprises:

 detecting each of the plurality of pipette tips using at least one sensor.

 43. A method for picking selected material portions separated in a gel
electrophoresis process, comprising:

25 providing a gel having a plurality of target areas;

 identifying at least one of the target areas for picking; and

 picking the identified at least one area using a robotically-controlled picking tool.

30 44. A modular station for performing automated liquid handling processes on
liquid materials in a sample holder under robotic control, comprising:

 a robot;

 a liquid handling tool controlled by the robot; and

at least one work tray having at least one position in which a sample holder may be operated on by the liquid handling tool, the work tray adapted to allow control of at least a temperature near a sample holder in the at least one position.

5 45. A control system for a set of modular processing stations adapted to perform a plurality of different processes on samples in sample holders, comprising:
 a storage device that stores a plurality of process tables, each process table defining a plurality of process steps; and
 a central controller that associates each sample holder with at least one process
10 table and generates control signals for each of the modular processing stations to perform processes on each sample holder.

 46. The system of claim 45, wherein the storage device stores a relational database in which at least one process table refers to at least two other process tables.

15 47. The system of claim 45, wherein the storage device stores at least one protocol association list for a protocol, the association list including a list of process tables associated with the protocol.

20 48. The system of claim 45, wherein the central controller generates control signals for a modular processing station to parallel process at least two sample holders.